

1. INTRODUCTION AND SUMMARY

1.1 PURPOSE AND SCOPE

This report documents an analysis of the Total System Life Cycle Cost (TSLCC) for one concept for the Civilian Radioactive Waste Management System (CRWMS). This analysis is consistent with the design basis of the selected alternative, Enhanced Design Alternative II (EDA II), evaluated in the *License Application Design Selection Report* (CRWMS M&O 1999c). Two cost scenarios are presented within this document to address open policy questions relating to the implementation of the EDA II design from the License Applications Design Selection (LADS) study. Both cases represent the total system cost for the EDA II design described in the LADS Report, modified for emplacing all planned waste quantities in the *Civilian Radioactive Waste Management System Requirements Document*, Rev. 05 (DOE 1999a). Case 1 assumes that closure and decommissioning activities can begin 50 years after the beginning of waste emplacement. Subsequent to the publication of the LADS Report (CRWMS M&O 1999c), discussions with the Nuclear Waste Technical Review Board (NWTRB) led to the consideration of keeping the repository open and ventilated for an additional 75 years. Case 2 represents the contingency of beginning closure and decommissioning activities 125 years after the beginning of waste emplacement, when it is expected that the temperature of the emplacement drift walls will remain below the boiling point of water.

This TSLCC updates the previous document *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program* (DOE 1998a). The major difference between these documents is the inclusion of EDA II design elements. The 1998 TSLCC was based on the design presented in the *Viability Assessment of a Repository at Yucca Mountain* (DOE 1998b). This TSLCC update is based on approved program design and direction current at the end of fiscal year (FY) 1999. When new program design information becomes available and is approved, this TSLCC estimate will be updated with a revision if there is a significant cost impact to the program.

Changes to the technical work scope, cost and schedule baselines, and selected management documents are executed via baseline change proposals (BCPs) or change requests (CRs). Both methods for change implement processes that support configuration control, and ensure integration, accountability, and traceability of decisions through the standardization of required information. The *OCRWM Program Baseline Change Control Procedure* (DOE 1997), and the *Integrated Planning, Change Request Preparation, and Baseline Change Implementation* (YAP-30.61) procedure are used to establish the responsibilities and processes for approving initial issues of and changes to the CRWMS.

This TSLCC estimate aids in financial planning, provides policy makers information for determining the course of the program, and is an input to a subsequent report on the adequacy of the one mill (\$0.001) per kilowatt-hour fee charged on generators of commercial spent nuclear fuel (SNF). Since these estimates are for a system that spans an additional 70 to 145 years into the future, the concept costed should be viewed as representative of the system that will ultimately be developed.

The TSLCC estimate is based on acceptance and disposal of approximately 86,300 metric tons of heavy metal (MTHM) of commercial SNF, including mixed oxide (MOX) fuel. The estimate is also based on 2,570 MTHM of government-managed SNF, including naval SNF, and approximately 20,000 canisters of vitrified high-level waste (HLW), including some canisters containing immobilized plutonium waste forms (IPWF) contained in HLW glass. The estimate of commercial SNF assumes existing nuclear power reactors operate for their planned service life under current Nuclear Regulatory Commission (NRC) licenses. While little additional generation of HLW is expected at U.S. Department of Energy (DOE) sites in the future, quantities of HLW canisters may vary due to uncertainties in the planned processing and vitrification of the wastes.

The DOE is aware that existing law prohibits emplacement in the first repository of a quantity of spent fuel containing in excess of 70,000 MTHM, until such time as a second repository is in operation. However, current cost information, designs, or authorization for a second repository do not exist. Therefore, consistent with the 1998 TSLCC, a one-repository system without interim storage, has been assumed. Yucca Mountain is assumed to be the location for the repository since it is the only location that the DOE is authorized to characterize. This, however, does not constitute a pre-decision on the determination of Yucca Mountain as an acceptable site for the repository.

This TSLCC estimate should not be interpreted as a final estimate. Numerous assumptions were required with respect to waste management system design and operations where decisions have not yet been made. These assumptions are critical to the resulting cost estimate, and any changes in assumptions could influence the resulting estimate. Assumptions used in this analysis are for cost purposes, and should not be interpreted as final Office of the Civilian Radioactive Waste Management (OCRWM) or DOE policy.

Alternative designs and approaches for implementing the repository system have been and will continue to be analyzed. These analyses have shown that there are various ways for the program to proceed on schedule with various cash flow profiles, including lower annual funding requirements for the near-term years. Alternative implementation options include: early acceptance of waste; varying receipt rates; modular construction of the surface and underground repository facilities; varying the amount of spent fuel in lag storage; and using an approach to transportation with lower initial capital investment than the rail branch line to the Yucca Mountain site. Although these options can lower near-term repository cash flow profiles, they generally increase the TSLCC and vary costs to utilities for storage at their sites, depending on the rates of acceptance at the repository.

This TSLCC analysis is organized as follows:

Section 1. INTRODUCTION AND SUMMARY: This section introduces the reader to the overall purpose and scope of this analysis, and summarizes the results and conclusions.

Section 2. SYSTEM DESIGN: This section provides a description of the reference design, including an explanation of design differences between EDA II and the Viability Assessment (VA).

Section 3. **MONITORED GEOLOGIC REPOSITORY:** This section discusses the Monitored Geologic Repository (MGR) scope, assumptions, and costs included for each of six phases of the system life cycle.

Section 4. **WASTE ACCEPTANCE, STORAGE AND TRANSPORTATION:** This section discusses the Waste Acceptance, Storage and Transportation (WAST) scope, assumptions, and costs included for each of three phases, and for the construction of the Nevada rail.

Section 5. **PROGRAM INTEGRATION:** This section discusses Program Integration scope, assumptions and costs associated with this activity.

Section 6. **INSTITUTIONAL:** This section discusses Institutional scope, assumptions, and costs associated with this activity. It also provides a description of Payment-Equal-to-Taxes (PETT), Benefits, 180(c) grants, and financial assistance.

Section 7. **COST SHARE ALLOCATION:** This section presents the cost share allocations for life cycle costs for civilian and government-managed nuclear material, and West Valley (WV) HLW programs.

Section 8. **REFERENCES:** This section contains a list of references used throughout this document.

Appendix A. **1999 TOTAL SYSTEM LIFE CYCLE COST ESTIMATE SUMMARY:** This section provides a summary of the 1999 TSLCC estimate by major cost categories, with breakouts of historical and future costs.

Appendix B. **COMPARISON WITH 1998 TOTAL SYSTEM LIFE CYCLE COST:** This section contains tables and text comparing the 1998 TSLCC (DOE 1998a) and the results of this analysis.

1.2 SUMMARY OF RESULTS AND CONCLUSIONS

Our national strategy maintains a clear focus on the long-term objective of waste disposal in a geologic repository. The scientific study of Yucca Mountain indicates that a repository can be designed and built at a site that would safely isolate SNF and radioactive HLW, and protect the public and the environment for tens of thousands of years.

The total estimated future cost to complete the program is \$43.9 Billion from 2000 through closure and decommissioning in 2069 for Case 1, and \$49.2 Billion for closure and decommissioning in 2144 for Case 2. A total of \$6.3 Billion was spent on the total program through FY 1999 in year-of-expenditure (YOE) dollars. Table 1 provides a summary of the major CRWMS cost categories. The program is assumed to continue from its inception in 1983 through closure and decommissioning of the repository in 2069 for Case 1, and in 2144 for Case 2. An annual breakout of costs is provided in Appendix A.

Table 1. Summary of Results (in Millions of 1999\$)

Cost Element	Historical Costs (1983-1999)	Case 1 Future Costs (2000-2069)	Case 2 Future Costs (2000-2144)
Monitored Geologic Repository	5,340	32,130	36,590
Waste Acceptance, Storage & Transportation	490	5,140	5,140
Nevada Transportation	0	790	790
Program Integration	1,590	2,130	2,610
Institutional	230	3,730	4,110
Total	7,650	43,920	49,240

NOTE: Historical costs total \$6.3 Billion YOE.

1.3 CHANGE CONTROL

The 1999 TSLCC documents the design changes and subsequent cost changes that have occurred since the publication of the 1998 TSLCC (DOE 1998a). These design changes follow either the established baseline change control procedure or change request procedure that culminates in the approval of a BCP or CR, respectively. Table 2 is a listing of the BCPs (CRWMS M&O 1999d) and CRs (DOE 1999d) that have been developed since the publication of the 1998 TSLCC in December 1998, and that have been used as a basis for this TSLCC estimate.

Table 2. BCPs and CRs Since December 1998

No.	Approved Description
Approved Baseline Change Proposals	
BCP-00-00-001	Issuance of the Civilian Radioactive Waste Management System Requirements Document (CRD), Rev. 5, and approval to incorporate associated changes into the Waste Acceptance Requirements Document (WA-SRD), Rev. 3
BCP-00-99-0002	Approval of the integrated Interface Control Document (ICD)
BCP-00-99-0003	Control of reference information for the Office of Civilian Radioactive Waste Management (OCRWM) Program life cycle
BCP-00-99-0004	Issue Document Change Notice (DCN) 01 to incorporate interim Regulatory Guidance into the Civilian Radioactive Waste Management System Requirements Document (CRD), Rev. 5
BCP-00-99-0006	Issue Document Change Notice (DCN) to the Civilian Radioactive Waste Management System Requirements Document (CRD), Rev. 5, to add the requirement to provide solar power for the Subsurface Emplacement Ventilation System
BCP-00-99-0007	Issue Document Change Notice (DCN) to the Civilian Radioactive Waste Management Systems Requirement Document (CRD), Rev. 5, to change the preclosure period to 50 years after the start of initial waste emplacement
BCP-00-99-0008	Issue/baseline Revision 3 of the Office of Civilian Radioactive Waste Management (OCRWM) Program Work Breakdown Structure (WBS) and Dictionary
BCP-00-99-0009	Incorporate License Application Design Selection (LADS) Enhanced Design Alternative (EDA) II into the YMSCO Project Baseline
BCP-03-99-0001	Issue/baseline Revision 3 of the Waste Acceptance System Requirements Document (WA-SRD)

Table 2. BCPs and CRs Since December 1998 (Continued)

No.	Approved Description
Approved Baseline Change Proposals	
BCP-03-99-0002	Issue/baseline Revision 4 of the Office of Civilian Radioactive Waste Management (OCRWM) Waste Acceptance, Storage and Transportation (WAST) Project Work Breakdown Structure (WBS) and Dictionary
BCP-03-99-0003	Issue/baseline Revision 5 of the Office of Civilian Radioactive Waste Management (OCRWM) Waste Acceptance, Storage and Transportation (WAST) Project Cost and Schedule Baseline
Approved YMP Change Requests	
CR 2000/001	Revision to the Project Cost & Schedule Baseline Document to update planning for FY00-FY03 in YMP Multiyear Cost & Schedule Baseline

1.4 PROGRAM ASSUMPTIONS

The program level assumptions have not changed significantly since the 1998 TSLCC. The change to the EDA II design basis is a change to the MGR assumptions. The key differences in program level assumptions between the 1998 TSLCC Report (DOE 1998a) and this report are as follows:

1. Costs will be in constant FY 1999 dollars. New escalation rates based on a 1999 cost escalation report (CRWMS M&O 1999a) will be used.
2. The repository life cycle for Case 1 ends in 2069, assuming closure and decommissioning activities begin 50 years after the start of emplacement. Case 2 assumes closure and decommissioning activities begin 125 years after the start of emplacement, with the life cycle ending in 2144.
3. The assumed quantity of waste packages decreased from 15,706 to 15,454 due to blending hot fuel with cold fuel. It is assumed that blending will reduce the quantity of small pressurized water reactor (PWR) waste packages.
4. The MGR monitoring operations time phases changed from 2041 – 2110 to:
 - a. Case 1 2041 – 2060
 - b. Case 2 2041 – 2135
5. The MGR closure and decommissioning time phases changed from 2110 – 2116 to:
 - a. Case 1 2060 – 2069
 - b. Case 2 2135 – 2144

1.5 COSTING APPROACH

The cost estimates make assumptions regarding technical and policy decisions; some will not be made until after the Secretary of Energy issues a site recommendation (SR) report to the President in 2001. The schedule assumes a license application (LA) to the NRC in 2002, NRC

authorization for construction approval in 2005, followed by NRC approval to receive and possess waste prior to the start of emplacement in 2010.

All future cost estimates are presented in constant 1999 dollars for ease of comparison and to eliminate the effects of inflation for a program with a duration of 70 to 145 years. Historical costs are noted in YOE dollars, and are escalated to 1999 dollars, using economic escalation indices for DOE construction projects to put all funds in constant year dollars (CRWMS M&O 1999a). This cost estimate does not include “take title” costs. Future cost estimates are rounded to the nearest \$10 Million for costs greater than \$100 Million.